*Process Evaluation Section*

# Reduction of Oxidative Melt Loss of Aluminum and Its Alloys

## Problem/Opportunity

Fabrication of virtually all finished aluminum products requires melting. During the melting process, an average of 4% of the input material is lost to oxidation. The lost material takes three forms in the furnace: (1) dross, a mixture of aluminum oxide compounds and aluminum metal typically skimmed from the surface of the melt; (2) inclusions entrained in the molten metal removed by filtration; and 3) oxide sludge found at the bottom of the melt.

**Skimming Operation for the Removal of Dross from an Aluminum Melting Furnace**

## Approach

The project is structured as a Collaborative Research and Development Agreement (CRADA) among SECAT, Argonne, Oak Ridge National Laboratory, and Albany Research Center. SECAT members that are participating in the project are: Alcan, ARCO Aluminum, Commonwealth Aluminum, Hydro Aluminum, IMCO Recycling, McCook Metals, and NSA Division of Southwire Co.

The objective of this project is to achieve a 50% reduction in oxidative melt loss and reduce dross from 4% to 2%. We will accomplish this objective by carefully controlling melt exposure to the furnace atmosphere, through the use of minor alloying elements that dramatically affect the kinetics of oxide growth, and by decreasing the melt surface / furnace atmospheric interface through various barrier techniques.

The project team will complete the following tasks:

1. Establish sampling procedures, tagging methods, archival storage, and web-based access to sample information.
2. Prepare industrial alloy standard materials for testing.
3. Characterize cast alloy samples for both average composition and variability among samples.
4. Analyze dross specimens from actual industrial melting processes to (1) determine the effects of variations in melt chemistry on dross formation, composition, and morphology; (2) establish general tendencies of elemental partitioning to dross; and (3) identify mechanisms for breakdown of protective alumina film on melt.
5. Use average composition aluminum ingots in test studies to monitor the kinetics of oxide formation.
6. Compare test-generated dross compositions with industrial samples.

7. Use kinetic studies conducted to time the transition between two-dimensional (2-D) and three-dimensional (3-D) dross growth in order to stop oxidation during the transition.
8. Investigate variables for specific alloys that have a large effect on dross growth rate.
9. Determine the effect of decreasing the melt exposure to atmosphere in order to delay 2-D to 3-D growth phase transition beyond typical melt cycle times.
10. Use industrial melt batches to validate dross limitation steps and to demonstrate that laboratory-scale studies accurately model conditions in industrial furnaces.
11. Model the thermodynamics, heat transfer, and diffusion during melting and oxidation of aluminum laboratory experiments and industrial experiments.

## Results

This project was initiated in August 2000. The project will identify melt conditions that will significantly reduce the oxidation of aluminum. The potential benefits of this project include estimated annual energy savings of 70 trillion Btu, lower costs for aluminum products, reduced industrial emissions and a significantly increased capability for recycling by the aluminum industry.

## Future Plans

Fabrication of virtually all finished aluminum products requires a melting step. This information developed during this project can be applied throughout the primary and secondary aluminum production industries.